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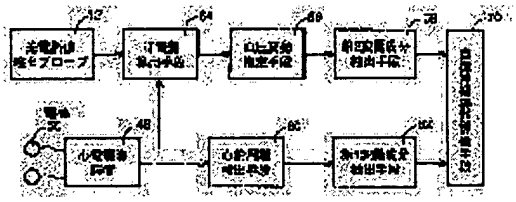
(54) EVALUATOR OF AUTONOMIC NERVE FUNCTION

(57)Abstract:
PROBLEM TO BE SOLVED: To enable handy and inexpensive evaluation of an autonomic nerve function of an organism.
SOLUTION: This apparatus evaluates the function of an autonomic nerve of an organism based on a first fluctuation component HFC comprising a frequency component almost equal to a respiration frequency of an organism which is extracted from a fluctuation of a pulse cycle TRR of the organism as detected continuously and a second fluctuation component LFC comprising a specified frequency component lower than the respiration frequency of the organism extracted from changes in the blood pressure value of the organism as detected continuously. A time difference TDRP is continuously calculated by a time difference calculation means 64 up to the maximum inclination point of a photoelectric pulse of the organism which is detected by a photoelectric pulse detection probe 12 sequentially from an R wave of an electrocardio induction wave of the organism detected sequentially by an electrocardio induction device 48. Changes in the inverse of the time difference TDPP are estimated by a blood pressure change estimation means 66 as changes in the blood pressure value.



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CLAIMS

[Claim(s)]
[Claim 1] The 1st fluctuation component which abbreviation's is in this living body's respiratory frequency extracted from fluctuation of a living body's cardiac cycle detected continuously by carrying out, and consists of a frequency component, In autonomic nerve functional-evaluation equipment by which a function of this living body's autonomic nerve is evaluated based on the 2nd fluctuation component which consists of a predetermined frequency component lower than this living body's respiratory frequency extracted from fluctuation of this living body's blood-pressure value measured continuously An electrocardio guide which detects serially an electrocardio induction wave generated in connection with action potential of said living body's myocardium, A plethysmogram sensor which detects serially a plethysmogram generated synchronizing with this living body's pulse, From a predetermined part generated for every electrocardio induction wave period of this living body serially detected with this electrocardio guide A time difference calculation means to compute continuously time difference to a predetermined part generated for every period of this living body's plethysmogram serially detected by this plethysmogram sensor, Autonomic nerve functional-evaluation equipment characterized by including a blood-pressure fluctuation presumption means to presume fluctuation of said blood-pressure value, based on fluctuation of time difference continuously computed by this time difference calculation means.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the autonomic nerve functional-evaluation equipment for evaluating the function of a living body's autonomic nerve.
[0002]
[Description of the Prior Art] If the cardiac cycle and blood-pressure value which are continuously measured from a living body have some fluctuation and carry out frequency analysis of the fluctuation of these cardiac cycles and a blood-pressure value, abbreviation etc. will be carried out, it will be in a living body's respiratory frequency, and two kinds of frequency components, a high-frequency component and about 1/3 low frequency component of a living body's respiratory frequency, will be obtained. And in order to evaluate the function of a living body's autonomic nerve using the low frequency component of which the high-frequency component called for from fluctuation of a cardiac cycle among these frequency components is asked for a parasympathetic nerve activity from fluctuation of a blood-pressure value reflecting a sympathetic nerve activity, carrying out frequency analysis of the cardiac cycle and blood-pressure value which are continuously measured from a living body is proposed.
[0003]
[Problem(s) to be Solved by the Invention] however, in order to evaluate the function of a living body's autonomic nerve Although a living body's cardiac cycle and blood-pressure value must be measured continuously beforehand, it is difficult to acquire a continuous living body's blood-pressure value with high degree of accuracy generally. For example Equipment with the special tonometer type automatic blood-pressure-measurement equipment which measures a blood-pressure value continuously using the pressure sensor pressed by a living body's radial artery needed to be used, and there was a defect that equipment became intricately and expensive.
[0004] Succeeding in this invention against the background of the above situations, the place made into the purpose is to offer the autonomic nerve functional-evaluation equipment by which the function of a living body's autonomic nerve can be evaluated simple and cheaply.
[0005]
[Means for Solving the Problem] A place made into a summary of this invention for attaining the above-mentioned purpose The 1st fluctuation component which abbreviation's is in a living body's respiratory frequency extracted from fluctuation of a living body's cardiac cycle detected continuously by carrying out, and consists of a frequency component, In autonomic nerve functional-evaluation equipment by which a function of a living body's autonomic nerve is evaluated based on the 2nd fluctuation component which consists of a predetermined frequency component lower than a living body's respiratory frequency extracted from fluctuation of a living body's blood-pressure value measured continuously (a) An electrocardio guide which detects serially an electrocardio induction wave generated in connection with action potential of said living body's myocardium, (b) A plethysmogram generated synchronizing with a living body's pulse, for example, a photoelectrical pulse wave detected from a photoelectrical pulse wave detection probe for pulse oximeters with which some living bodies are equipped, and which is mentioned later, Or a plethysmogram sensor which detects serially periodic pulsation of blood capacity in a predetermined part of living bodies, such as a cuff pulse wave detected from a cuff wound around some living bodies, (c) from a predetermined part generated for every electrocardio induction wave period of a living body serially detected with an electrocardio guide A time difference calculation means to compute continuously time difference to a predetermined part generated for every period of a living body's plethysmogram serially detected by plethysmogram sensor, (d) It is in including a blood-pressure fluctuation presumption means to presume fluctuation of said blood-pressure value, based on fluctuation of time difference continuously computed by time difference calculation means.

[0006]
[Effect of the Invention] If it does in this way, a living body's blood-pressure fluctuation measured in order to evaluate the function of an autonomic nerve Since it is presumed from fluctuation of the time difference from the predetermined part generated for every electrocardio induction wave period of the living body serially detected with an electrocardio guide to the predetermined part generated for every period of a living body's plethysmogram serially detected by the plethysmogram sensor The complicated and expensive equipment for performing continuous blood pressure measurement becomes unnecessary, and it becomes possible to evaluate the function of a living body's autonomic nerve simple and cheaply.
[0007]
[Embodiment of the Invention] Hereafter, one example of this invention is explained to details based on a drawing. Drawing 1 is the block diagram showing the oxymetry equipment 10 which functions also as autonomic nerve functional-evaluation equipment which is one example of this invention.
[0008] In drawing 1 , it is equipped with the photoelectrical pulse wave detection probe 12 (only henceforth a probe) for pulse oximeters in the condition of having stuck with the wearing band which is not illustrated to the body surfaces 14, such as an operating personnel-ed, for example, the finger tip section etc. The housing 16 of the shape of a container which carries out the opening of the probe 12 in an one direction, Two or more 1st light emitting device 18a which is prepared in the portion located in the periphery side of the bottom circles side of the housing 16, and consists of LED etc. And 2nd light emitting device 18b (the following, especially when not distinguishing, it is only called a light emitting device 18), The photo detector 20 which is prepared in a part for the center section of the bottom circles side of housing 16, and consists of a photodiode, a photo transistor, etc., The transparent resin 22 which is prepared in one in housing 16 and covers a light emitting device 18 and a photo detector 20, It is prepared between a light emitting device 18 and a photo detector 20 in housing 16, and it has the annular covered member 24 which shades the reflected light which goes to a photo detector 20, and consists of the body surface 14 of the light irradiated toward said body surface 14 from the light emitting device 18.
[0009] 1st light emitting device of the above 18a Light is emitted, for example in red light with a wavelength of about 660nm, and it is 2nd light emitting device 18b. For example, light is emitted in infrared light with a wavelength of about 800nm. These 1st light emitting device 18a And 2nd light emitting device 18b While being made to emit light with predetermined frequency by fixed time amount [every] sequence, the reflected light from the part by which it is crowded with the capillaries of the inside of the body of the light irradiated toward said body surface 14 from these light emitting devices 18 is received by the common photo detector 20, respectively. in addition, the wavelength of the light in which a light emitting device 18 emits light is restricted to the above-mentioned value -- not having -- 1st light emitting device 18a the light of the wavelength from which the absorbancy index of an oxyhemoglobin and the reduced hemoglobin differs greatly -- 2nd light emitting device 18b those absorbancy indexes -- abbreviation -- what is necessary is just to emit light in the light of the wavelength which becomes the same, respectively
[0010] It is the photoelectrical pulse wave signal SM 1 of the magnitude corresponding to the light income in a photo detector 20. It outputs through a low pass filter 26. Between a photo detector 20 and a low pass filter 26, amplifier etc. is formed suitably. photoelectrical pulse wave signal SM 1 into which the low pass filter 26 was inputted from -- signal SM 1 with which the noise which has frequency higher than the frequency of a pulse wave was removed, and the noise was removed It outputs to a demultiplexer 28.
[0011] A demultiplexer 28 follows a signal from an electronic control 30, and is 1st light emitting device 18a. And 2nd light emitting device 18b Electrical signal SMR according to red light by being switched synchronizing with luminescence The I/O Port with which an electronic control 30 does not illustrate the electrical signal SMIR by infrared light through a sample hold circuit 36 and A/D converter 38, respectively is serially supplied through a sample hold circuit 32 and A/D converter 34. Sample hold circuits 32 and 36 are for holding the electrical signal SMR which will be outputted to a degree by the time the conversion actuation in the electrical signal SMR outputted last time and A/D converters 34 and 38 about SMIR is completed, in case the inputted electrical signal SMR and SMIR are outputted to A/D converters 34 and 38, and SMIR, respectively. In this example, the above-mentioned probe 12 supports the plethysmogram sensor.
[0012] The saturation-of-oxygen measuring device 10 of this example is equipped with the electrocardio guide 48. It is the signal SM 2 which the electrocardio guide 48 detects continuously, the electrocardio induction wave, i.e., the electrocardiogram, showing the action potential of a myocardium through two or more electrodes 50 stuck on a living body's predetermined part, and shows the electrocardio induction wave. An electronic control 30 is supplied.
[0013] CPU40 of an electronic control 30 performs measurement actuation according to the program memorized beforehand to ROM44, using the memory storage function of RAM42. A control signal SLV is outputted to the drive

circuit 46, and they are light emitting device 18a and 18b. While making light emit fixed time amount every on predetermined frequency one by one These light emitting device 18a and 18b By outputting the change over signal SC synchronizing with luminescence, and switching a demultiplexer 28, it is said electrical signal SMR. An electrical signal SMIR is distributed to a sample hold circuit 32 in a sample hold circuit 36, respectively. The above CPU 40 computes a living body's saturation of oxygen in blood based on the above-mentioned electrical signal SMR and the amplitude value of SMIR from the operation expression memorized beforehand, in order to compute the saturation of oxygen in blood, and it is made to display it on a drop 52. In addition, as the decision method of this saturation of oxygen, the decision method indicated by JP,3-15440,A which these people applied previously and was exhibited is used, for example.

[0014] moreover, signal SM 2 with which CPU40 shows an electrocardio induction wave from -- while extracting fluctuation of a heart rate and its predetermined frequency -- the R wave of an electrocardio induction wave to photoelectrical pulse wave SMR Or fluctuation of the inverse number of the time difference TDRM to the predetermined part of SMIR and its predetermined frequency is extracted, and the function of a living body's autonomic nerve is evaluated based on the reinforcement of these fluctuation.

[0015] Drawing 2 is a functional block diagram explaining the important section of the control function of the electronic control 30 in the above-mentioned oxymetry equipment 10. In drawing 2 , the cardiac cycle detection means 60 detects a living body's cardiac cycle TRR continuously for every beat by computing the time interval of the electrocardio induction wave serially detected from said electrocardio guide 48, for example, the time interval between R waves. Thus, fluctuation as shown in drawing 3 exists in the cardiac cycle TRR detected continuously. The abbreviation of the 1st fluctuation component extract means 62 etc. is in a living body's respiratory frequency as shown in the continuous line of drawing 4 by carrying out from fluctuation of a living body's cardiac cycle TRR continuously detected by the above-mentioned cardiac cycle detection means 60, and they are the high-frequency component HFC 1, i.e., the 1st fluctuation component, and about 1/3 low frequency component LFC 1 of a living body's respiratory frequency. It extracts, respectively. this 1st fluctuation component extract means 62 -- a fast Fourier transform (FFT) -- law or autoregression (AR) -- frequency analysis of the fluctuation of a cardiac cycle TRR is carried out by using law etc.

[0016] The time difference calculation means 64 is, Point Pmax, i.e., the point inclining [maximum], that the predetermined part, for example, the differential wave of a photoelectrical pulse wave, generated for every period of the photoelectrical pulse wave serially detected from a probe 12, predetermined part, for example, R wave, generated for every electrocardio induction wave period serially detected from the electrocardio guide 48 as shown in drawing 4 , shows maximum. The time difference TDRM of until is computed continuously. Thus, fluctuation exists in the time difference TDRM computed continuously, for example, drawing 3 shows fluctuation of the inverse number of time difference TDRM.

[0017] The blood-pressure fluctuation presumption means 66 computes the inverse number of time difference TDRM continuously for every beat. Here under conditions predetermined [-- the blood-pressure fluctuation presumption means 66 has few other fluctuation factors --] The general relation that a living body's blood-pressure value becomes high, so that the propagation velocity of the pulse wave which spreads the inside of an artery becomes high exists. Since the pulse wave velocity has the inverse number of the above-mentioned time difference TDRM, and fixed relation, it presumes a living body's blood-pressure value continuously substantially by computing the inverse number of time difference TDRM. A living body's respiratory frequency, abbreviation, etc. are in the 2nd fluctuation component extract means 68 by carrying out from fluctuation of the inverse number of time difference TDRM, and they are the high-frequency component HFC 2 and the predetermined frequency component LFC 2 lower than a living body's respiratory frequency, i.e., the 2nd fluctuation component. It extracts. this 2nd fluctuation component extract means 68 -- a fast Fourier transform (FFT) -- law or autoregression (AR) -- frequency analysis of the fluctuation of the inverse number of time difference TDRM is carried out by using law etc. The autonomic nerve functional-evaluation means 70 is the above-mentioned 1st fluctuation component HFC 1. Low frequency component LFC 1 The numeric value which expresses the activity of a living body's parasympathetic nerve based on the ratio (HFC1 / LFC1) of signal strength The above-mentioned 2nd fluctuation component LFC 2 High-frequency component HFC 2 The display output of the numeric value which expresses the activity of a living body's sympathetic nerve based on the ratio (LFC2 / HFC2) of signal strength is carried out using a drop 52.

[0018] Drawing 5 is a flow chart explaining the important section of control actuation of the electronic control 30 in the above-mentioned autonomic nerve functional-evaluation equipment 10, and shows the routine performed synchronizing with a cardiac cycle.

[0019] In drawing 5 , a cardiac cycle TRR is computed by computing the time interval between the R waves of the electrocardio induction wave inputted from the electrocardio guide 48 by SA1 corresponding to said cardiac cycle

detection means 60. subsequently, fluctuation of the above-mentioned cardiac cycle TRR serially computed in SA2 corresponding to said 1st fluctuation component extract means 62 -- receiving -- for example, a fast Fourier transform (FFT) -- law or autoregression (AR) -- the 1st fluctuation component HFC 1 which consists of the frequency component which has the peak generated near a living body's respiratory frequency band (for example, 0.25Hz) by performing frequency analysis by law etc. It is extracted.

[0020] Next, photoelectrical pulse wave SMR inputted from a probe 12 in SA3 corresponding to the time difference calculation means 64 Or while the point of SMIR inclining [maximum] is determined, time difference TDRM is computed by computing the time interval from the R wave of the electrocardio induction wave inputted from the electrocardio guide 48 to the point of the photoelectrical pulse wave inclining [maximum]. Subsequently, in SA4 corresponding to the blood-pressure fluctuation presumption means 66, fluctuation of the inverse number of time difference TDRM is presumed as fluctuation of a blood-pressure value by computing the inverse number of time difference TDRM.

[0021] then -- SA5 corresponding to the 2nd fluctuation component extract means 68 -- fluctuation of the inverse number of this time difference TDRM computed serially -- receiving -- for example, a fast Fourier transform (FFT) -- law or autoregression (AR) -- the 2nd fluctuation component LFC 2 which consists of the frequency component which has the peak generated by performing frequency analysis by law etc. 1/3 of a living body's respiratory frequency thru/or near [about 1/4] a frequency band (for example, 0.07Hz) It is extracted.

[0022] And it sets to SA6 corresponding to said continuing autonomic nerve functional-evaluation means 70. The above-mentioned 1st fluctuation component HFC 1 Low frequency component LFC 1 The numeric value which expresses the activity of a living body's parasympathetic nerve based on the ratio (HFC1 / LFC1) of signal strength The above-mentioned 2nd fluctuation component LFC 2 High-frequency component HFC 2 The display output of the numeric value which expresses the activity of a living body's sympathetic nerve based on the ratio (LFC2 / HFC2) of signal strength is carried out using a drop 52. For example, the display screen using emitters, such as liquid crystal or LED, as a drop 52 or a printer is used. The activity of a living body's parasympathetic nerve and the sympathetic nerve may be displayed by the trend graph etc. in addition to the above-mentioned numeric value.

[0023] As mentioned above, fluctuation of a living body's blood-pressure value required according to this example, in order to evaluate the function of an autonomic nerve measured continuously predetermined part, for example, R wave, generated for every electrocardio induction wave period of the living body serially detected with the electrocardio guide 48 Since it is substantially presumed from fluctuation of the time difference TDRM to predetermined part, for example, point inclining [maximum], generated for every period of a living body's photoelectrical pulse wave (equivalent to said pulse synchronization voltage) serially detected by the probe 12 (equivalent to said pulse synchronization voltage sensor) The complicated and expensive equipment for performing continuous blood pressure measurement becomes unnecessary, and it becomes possible to evaluate the function of a living body's autonomic nerve simple and cheaply.

[0024] Moreover, according to this example, are in charge of evaluating a living body's autonomic nerve function. The above-mentioned 1st fluctuation component HFC 1 Low frequency component LFC 1 The numeric value which expresses the activity of a living body's parasympathetic nerve based on the ratio (HFC1 / LFC1) of signal strength The above-mentioned 2nd fluctuation component LFC 2 High-frequency component HFC 2 Since the display output of the numeric value which expresses the activity of a living body's sympathetic nerve based on the ratio (LFC2 / HFC2) of signal strength is carried out using the drop 52, The 1st fluctuation component HFC 1 The 2nd fluctuation component LFC 2 Like [in case the display output of the absolute value is carried out] It is lost that a difference of the signal strength between the living bodies of the whole frequency curve shown in drawing 4 based on other factors other than an autonomic nerve function is accidentally judged as a difference of an autonomic nerve function, and evaluation precision improves.

[0025] As mentioned above, although one example of this invention was explained to details based on the drawing, this invention is applied also in other modes.

[0026] For example, in the above-mentioned example, although the photoelectrical pulse wave serially detected from the photoelectrical pulse wave detection probe 12 for pulse oximeters was used as said plethysmogram, the cuff pulse wave detected from the cuff which was wound around some living bodies and held at place constant pressure may be used as said plethysmogram. In such a case, it is constituted as automatic blood-pressure-measurement equipment equipped with the autonomic nerve evaluation function.

[0027] Moreover, in the above-mentioned example, although the probe 12 for photoelectrical pulse wave detection of the reflective mold which detects the reflected light reflected in a living body's body surface 14 was used, of course, it does not matter even if the probe for photoelectrical pulse wave detection of the transparency mold which detects the transmitted light which penetrated a living body's body tissue is used.

[0028] Moreover, although a living body's cardiac cycle TRR was continuously detected by computing the recurrence interval of the electrocardio induction wave period detected with the electrocardio guide 48, for example, an R wave, for every beat in the above-mentioned example Compute the period of the pulse wave detected from a living body's artery by the pressure sensor with which the radial artery of the cuff wound around some living bodies or a living body is equipped for every pulse wave, or Or even if it is constituted so that a living body's cardiac cycle TRR may be continuously detected by computing the period of the photoelectrical pulse wave detected by the probe for photoelectrical pulse wave detection for every pulse wave, it does not interfere. In short, a cardiac cycle detection means to detect a living body's cardiac cycle continuously should just be established.

[0029] Moreover, in the above-mentioned example, although time difference TDRP was computed by computing the time interval from the R wave of an electrocardio induction wave to the point of a photoelectrical pulse wave inclining [maximum], various modes -- for example, time difference TDRP is computed by computing the time interval from the Q wave or S wave of an electrocardio induction wave to the maximum point or minimum point of a photoelectrical pulse wave -- can be considered.

[0030] In addition to this in the range in which this invention does not deviate from the main point, various modification may be added.

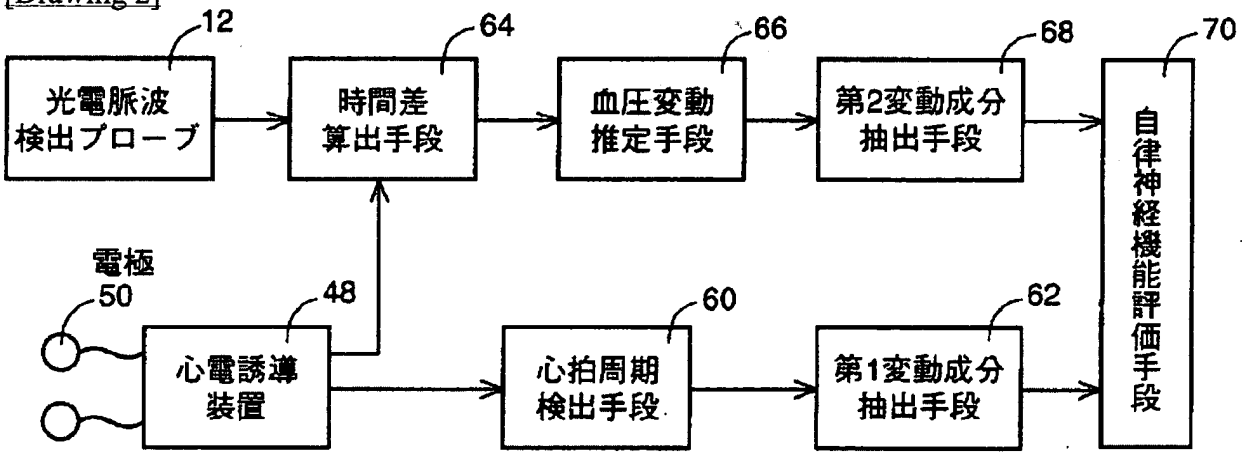
[Translation done.]

* NOTICES *

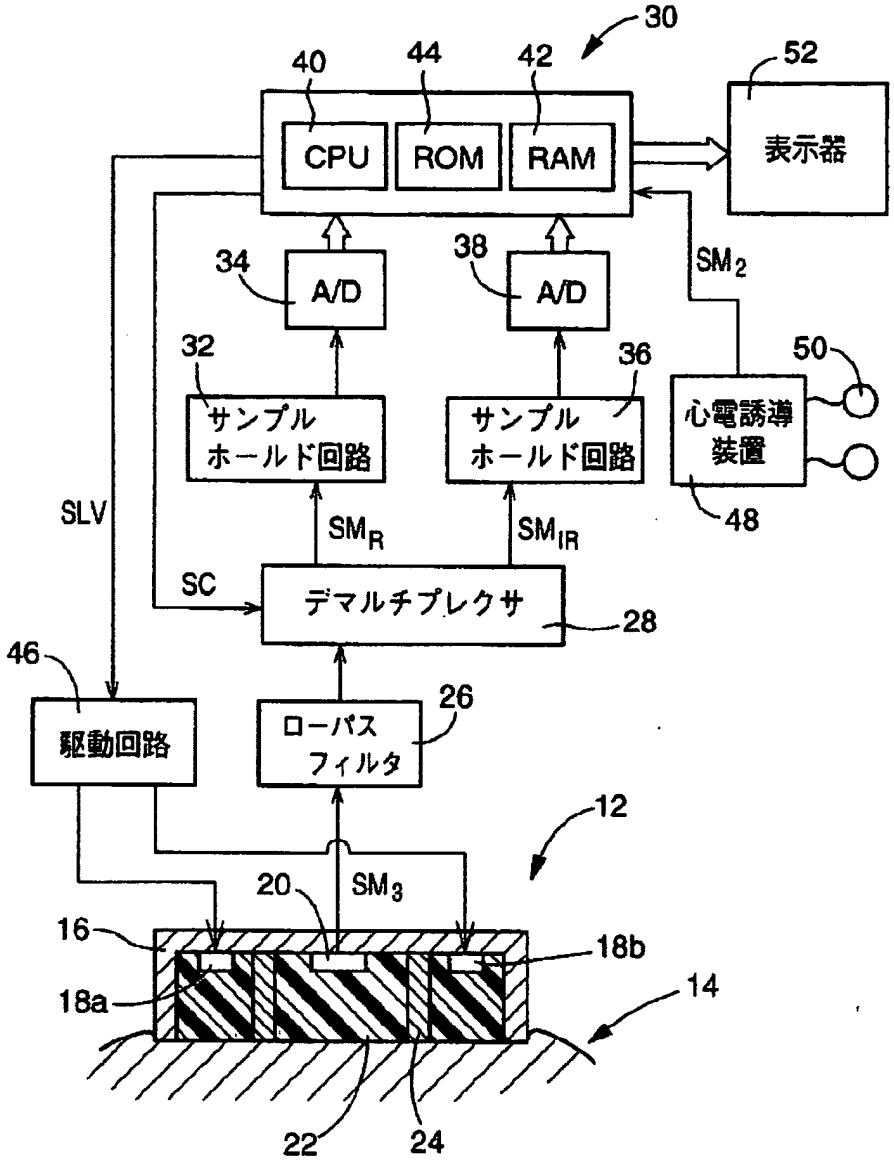
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

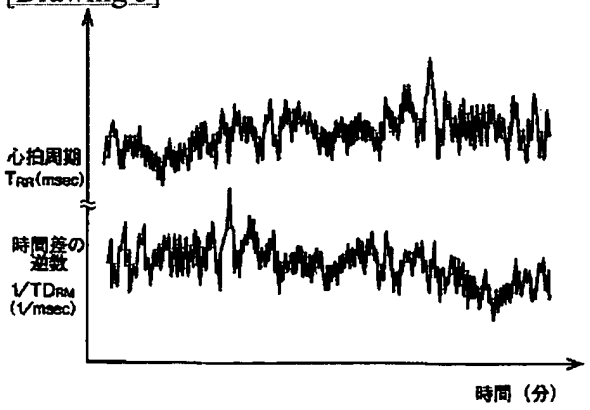
[Drawing 2]



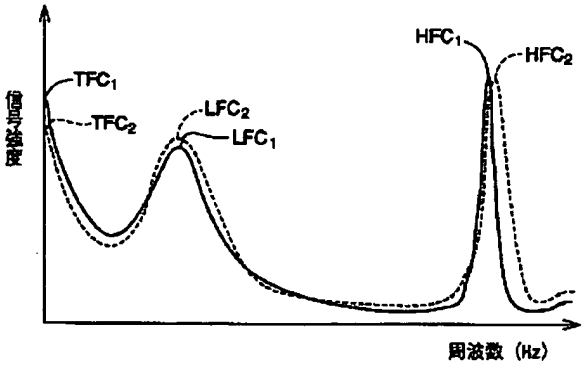
[Drawing 1]



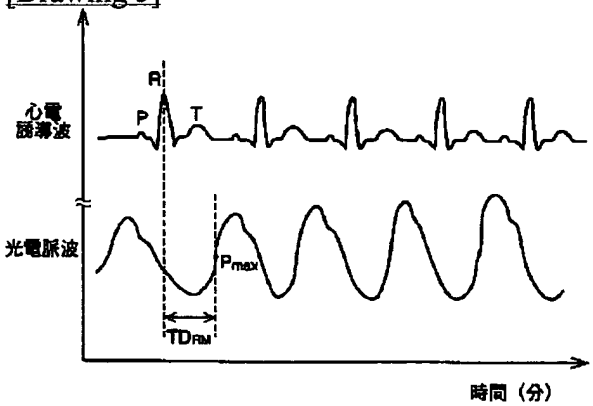
[Drawing 3]



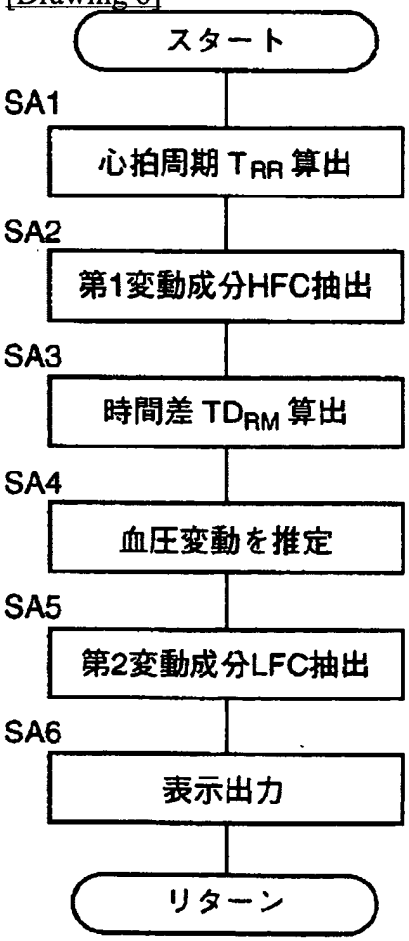
[Drawing 4]



[Drawing 5]



[Drawing 6]



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